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X.—*Notes on some Earthworms from Ceylon and the Philippine Islands, including a Description of two new Species.*
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[Plate II.]

THE following notes refer to a number of earthworms which I have had the opportunity of dissecting during the past year. The specimens were in no case in any fit condition for histological examination, and the descriptions of the rough anatomy are in many points incomplete. I have thought, however, that the observations are worth publishing, because they relate in two cases to new species, one of which at any rate (*Perichæta ceylonica*) possesses certain structural features hitherto unknown in the genus to which it belongs.

Perichæta ceylonica, n. sp. (Pl. II. figs. 1–3.)

Several species of his genus *Perichæta* have been described by Schmarda * from the island of Ceylon; but in no case are these descriptions, although accompanied by chromo-lithographs, of much use, since they refer only to external characters, and even these are recorded in a very meagre fashion. It is therefore a matter of total impossibility to

* Neue wirbell. Thiere, Bd. ii.

decide whether the present species is really new to science or is identical with one of the four species recorded by Schmarda. I am not aware of any means of solving the difficulty, and therefore venture to describe the present species under a new name, indicating its habitat, since it clearly differs from any *Perichæta* whose anatomy is known and whose specific distinctness can on this account be determined with certainty.

I have only had the opportunity of examining a single specimen of the earthworm, which I owe to the kindness of Dr. Ondaatje.

The worm measures 9 inches in length by about 10 millim. in breadth; it is of an intense black colour on the dorsal surface, of a dark grey on the ventral surface. In the region of the clitellum the colour of the ventral surface differs, and is black, like that of the dorsal surface.

The *clitellum* is so far different from that of other *Perichæta* that it is not sharply marked off from the rest of the integument either anteriorly or posteriorly; this may be due to the inferior state of preservation of the specimen, but is probably not so; other species of the genus that I have recently examined, although softened and injured by preservation in weak alcohol, still retain the characteristic distinctness of the clitellum, which in this genus is continued right round the body without a break and is not saddle-shaped, as in *Lumbricus* and many other genera. The clitellum of *Perichæta ceylonica* occupies segments 14, 15, 16, and a part of 17.

The *setæ*, as in the majority of species, form a continuous row round the middle of each segment; in the ventral median line, however, a minute median area remains devoid of *setæ*; it did not appear to me that there was anything characteristic in the shape of the *setæ*.

The apertures of the spermathecæ are conspicuous on the boundary-line between segments 8 and 9; they are widely separated from each other.

On the 18th segment are the male generative openings, which present an arrangement unlike that met with in any other species of the genus at present known. The row of *setæ*, which in all the other segments of the body is continuous or very nearly so round the middle of the segment, stops short of the middle line in the 18th segment, leaving a median space of 3.5 millim. in extent entirely devoid of *setæ*. On either side of this bare patch is a conspicuous orifice (fig. 1, *b*), through which protrude one or two peculiarly modified *setæ* generally known as "penial" *setæ*. On the left side of the body in the specimen before me there are two such *setæ*, on the right only one. The general shape of these *setæ* can be understood

by an inspection of fig. 3; the distal and proximal ends are slightly curved and convergent, while the middle portion is straight; the distal extremity of the seta which protrudes through the orifice ends in a sharp point and is furnished with a series of minutely serrated ridges which are at first regular, but as they approach the tip become broken up; fig. 3 *a*, which is a highly magnified representation of this portion of the seta, shows its characteristic form and is better than any description. It is only the distal one fourth of the seta which is thus ornamented; the ridges gradually disappear behind.

In front of the aperture through which protrude these penial setæ, and therefore close to the anterior limit of the segment, is another pair of apertures (fig. 1, *a*), approximately in the same straight line with the posterior orifices. The two apertures of each side of the body are situated upon a flattened area differing somewhat in its appearance from the rest of the integument. The internal structures corresponding to these apertures are peculiar: the anterior pair of orifices lead in each case into a long somewhat coiled tube, ending cæcally and of uniform diameter throughout (fig. 2, *a*); with each of the posterior pair of apertures is connected a large brown gland (fig. 2, *b*), divided by deep furrows into a multitude of minute lobules; this prostate gland opens to the exterior by a long somewhat curved muscular duct; on the left side of the body the gland extended through five segments, commencing with and including the eighteenth; on the posterior side of the duct of the prostate gland is a thin-walled sac (*c*) containing the penial setæ already referred to. I am unable to state the relations of the vasa deferentia to these two glands, since they, as well as the testes, could not be recognized.

With the exception of a single species described by myself* no *Perichaeta* is known which possesses these peculiarly modified penial setæ; they are, however, characteristic of other genera (e. g. *Acanthodrilus*, *Eudrilus*, *Typhæus*), and present more or less the same form in all, differing widely from the ordinary setæ of the body.

The complication of the prostate glands in *Perichaeta ceylonica* is a new feature in the organization of this or any other genus.

A multifid prostate gland, like the posterior gland of *P. ceylonica*, is characteristic of the genus *Perichaeta* and is found in all species of the genus with but trifling modification in shape, depending upon the more or less complete lobulation of

* *P. armata*, Ann. & Mag. Nat. Hist. 1883, p. 216.

the gland. A simple tubular prostate is characteristic of the genera *Eudrilus*, *Pontodrilus*, and *Typhæus*, where it is either a straight uniform tube (*Eudrilus*) or curved. *Acanthodrilus* for the most part agrees with the last-named genera in the form of the prostate glands, but differs in so far that there are two pairs instead of only one. In some genera (*Lumbricus*, *Microchaeta*) there are no prostate glands at all. *Perichæta ceylonica* therefore combines the characters of *Perichæta* and *Acanthodrilus*; it agrees with the former genus in the distribution of its setæ, while the generative organs approximate in many points to those of *Acanthodrilus*.

In *Acanthodrilus*, as already stated, there are two pairs of prostate glands, to each of which corresponds a bundle of penial setæ; the apertures of these glands are, in the majority of species, upon the 16th and 18th segment; there is usually a segment interposed between the two pairs of orifices. In one species, however, if I do not misinterpret M. Perrier's statements, there is a slight difference. In this species (*Acanthodrilus verticillatus*) the two pairs of orifices are more closely approximated, being situated upon the 17th and 18th segments. *Perichæta ceylonica* forms a third term in the series; there are four male generative apertures, but these are all upon the same segment (the 18th), one pair behind the other*. Finally we have, as in the vast majority of earthworms, a single pair of male generative apertures with or without prostate glands. It is interesting also to notice that the prostate glands of *P. ceylonica* combine characters that are found in different genera, but here united in the same species; one pair of prostate glands are typically "Perichætaous;" the anterior pair are like those of *Pontodrilus* and other genera.

There is a single pair of copulatory pouches present which, as already observed, open to the exterior on the boundary-line between the 8th and 9th segments: the copulatory pouches are large in proportion to the size of the animal; each is furnished with a simple diverticulum, as in *P. post-*

* Perhaps the genus *Eudrilus* resembles *Perichæta ceylonica* in these respects. M. Perrier's description of the male generative organs in that genus are unfortunately not very complete, owing to the inferior state of preservation of the specimens at his disposal. In the description of the genus *Eudrilus* (Nouv. Arch. de Mus. t. viii. p. 74) he speaks of two different glandular (?) structures uniting together with the vas deferens to open to the exterior; the first of these is an elongated organ, which is compared to the prostate of other earthworms; the second is a Y-shaped tube which opens into the dilated distal extremity of the vas deferens separately from the former. These structures are stated to occur in *E. Lacazii*, *E. jeregrinus*, and *E. decipiens*.

huma (fig. 7). There appear to be no nephridia present, but the poor condition of the specimen does not permit me to speak with certainty.

The dorsal vessel is united with the ventral by several transverse trunks in the anterior part of the body; in segments 11, 12, and 13 are three large pairs of transverse trunks arising from the supra-intestinal vessel and uniting this with the supra-nervian; these correspond to the "œours intestinaux" of Perrier, who has described similar transverse vessels in *Urochæta* * and in *Pontodrilus* †.

Perichæta Houletti, E. P.

Perichæta Houletti, E. Perrier, Nouv. Arch. d. Mus. t. viii. p. 99.

This species has been recorded by M. Perrier from Calcutta and from Cochin China. Among a large number of earth-worms from Manila which I owe to the kindness of my friend Mr. H. E. Barwell I observed a single specimen evidently referable to the same species. The peculiar form of the copulatory pouches, unlike that occurring in any other *Perichæta*, renders the identification of my specimen with the species described by M. Perrier a matter of certainty.

Perichæta posthuma. (Pl. II. fig. 7.)

Perichæta posthuma, Vaillant, Ann. Sci. Nat. 1868.

Perichæta affinis, E. Perrier, Nouv. Arch. d. Mus. t. viii. p. 106.

Megascolex affinis, F. E. Beddard, Ann. & Mag. Nat. Hist.

Dr. Horst has called attention † to the identity that really exists between Vaillant's species *Perichæta posthuma* and *P. affinis* of Perrier; if his identification be correct, it is obviously necessary to cancel the name *P. affinis*.

A large number of examples of a small species of *Perichæta* from the neighbourhood of Manila evidently belong to this species; they present at any rate the following points of agreement with the description as given by Perrier:—The male generative apertures, situated on the 18th segment (the second behind the clitellum), are preceded and succeeded by a pair of genital papillæ on the adjoining segments; the copulatory pouches are situated in segments 6, 7, 8, 9; each consists of an oval sac with a small tubular diverticulum; the two last pairs of copulatory pouches are situated in the segment which contains the gizzard; it is evident therefore that this segment, though not divided by a mesentery, is composed of two fused segments. Testes in segments 11 and 12; a

* Arch. de Zool. Exp. t. iii.

† *Ibid.* t. ix.

‡ 'Notes from the Leyden Museum,' vol. v.

vast number of œsophageal glands in segments 6 and 7 evidently metamorphosed nephridia.

The above facts are sufficient to show that I am right in identifying this species with *Perichæta posthuma* or at least with *P. affinis*. The point that I wish to call attention to, however, is the variability in number and in position of the copulatory pouches, and this is a matter of some little importance from the point of view of the determination of species.

In the majority of specimens there were four pairs of copulatory pouches with the distribution already recorded. Another specimen fully mature had only three pairs, while in a second equally mature there were four pairs, but the left-hand pouch of the seventh segment was extremely small and rudimentary. A third example, with well-developed clitellum and testes, had no trace whatever (visible to the naked eye) of copulatory pouches. These facts show that the copulatory pouches are not necessarily developed *pari passu* with the testes and clitellum; the absence of these structures in *Titanus* is possibly therefore only apparent.

The most remarkable variation in the copulatory pouches that I have observed in this species is illustrated in fig. 7; in this example there were three copulatory pouches present, situated in a row on the right hand side of the nerve-cord in the eighth segment.

Moniligaster Barwelli, n. sp. (Pl. II. figs. 4-6.)

I owe to the kindness of my friend Mr. H. E. Barwell, who is at present resident in Manila, a number of examples of a small earthworm from the neighbourhood of that town which appear to belong to Perrier's genus *Moniligaster*.

Moniligaster is at present only known by one species (*M. Deshayesi* *), a native of Ceylon, which is characterized by the apparent absence of a clitellum and by the very remarkable disposition of the œsophagus; instead of being furnished with but a single gizzard, as in the majority of earthworms, or with two, as in *Digaster*, the œsophagus of *Moniligaster* has five distinct gizzards, one situated in the sixth ring of the body and separated by an interval from four other separate gizzards, which are in close connexion with each other and pass immediately into the intestine.

Moniligaster Barwelli is a small earthworm not more than $1\frac{1}{2}$ inch in length, judging at least from some twenty examples which I have had the opportunity of examining; the other

* Nouv. Arch. d. Mus. t. viii. p. 130.

species, according to Perrier, is 150 millim. or 6 inches in length.

The body of the worm is somewhat flattened from above downwards, and is of a greenish colour and very translucent, so much so that even in the alcohol-preserved specimens the nervous system, the ventral blood-vessel, and in places the segmental organs were quite visible from the outside.

I was unable to discover any traces of a clitellum, and inasmuch as the generative organs appeared to be well developed, the absence of this structure can hardly be accounted for by presuming the specimens to be immature. It is at least a curious fact that not a single one of twenty specimens had any trace of clitellum; it would be obviously hasty to insist upon the absence of a clitellum so generally found in earthworms until there is some more definite proof; but, as already stated, Perrier was unable to find any clitellum in a single example of *M. Deshayesi* examined by him, and the coincidence is remarkable.

The only apertures that I could detect upon the surface of the body besides the mouth and anus were two oval slit-like orifices with tumid yellowish lips, which are the male generative orifices, and are situated between segments 9 and 10 between the ventral and dorsal pairs of setæ. The setæ are disposed precisely as in *M. Deshayesi*, viz. in four series of pairs; the setæ of each pair are very closely approximated. In the disposition of the œsophagus this new species agrees in the main with *M. Deshayesi*; in one specimen at any rate there were four oval nacreous-looking dilatations of the œsophagus close to its junction with the intestine; the anterior gizzard of *M. Deshayesi* of the sixth segment appears to be absent in this specimen.

There are well-developed nephridia in all the segments of the body.

Generative Organs.—The ovaries and their ducts I have been entirely unable to discover.

The testes are present to the number of a single pair of large oval compact glands, situated in the 9th segment. The relation of the vas deferens to the testes will be apparent from the accompanying figure (fig. 4); it is a thin, delicate, much coiled tube which expands when it reaches the testis and appears to become continuous with its covering. I did not succeed in detecting any funnel-like expansion separate from the testis. The vas deferens (*v.d.*) passes down towards the ventral side of the segment, and its termination on the boundary line between the 9th and 10th segments is furnished with a small oval gland (*p*) which corresponds to the prostate gland of other

Oligochæta. A portion of the vas deferens highly magnified is shown in fig. 6; it consists of a single layer of ciliated cuboid cells, each containing a large nucleus; in structure it is precisely similar to that of other earthworms. I have figured a portion to show that there has been no mistake on my part in the identification of the vas deferens, which differs in several points from the vas deferens of other earthworms. These differences consist mainly in the fact that it lies chiefly in the same segment as the testis, opening between this segment and the next, and that there is only a single vas deferens on either side of the body. The figure to which I have referred illustrates this point; it represents the testicular segment seen from behind: T is the large oval testis, *v.d.* the coiled vas deferens, and *p* the prostate, in common with which the vas deferens opens; *æ* is the œsophagus seen in section; D and *y*, the dorsal and ventral blood-vessels respectively; the transverse trunk or heart (*v.s.*) which unites the two gives off a large vessel which presently divides into two branches, one passing up to the testis, the other supplying the prostate.

Evidently therefore this earthworm, in the structure of the male generative organs, assimilates very closely to the type of structure characteristic of, though not always found in, the Limicolous Oligochæta. Where there is but a single vas deferens on either side of the body, as in the Naidomorpha, Chaetogastridæ, Tubificidæ, and Enchytraidæ, its external aperture is situated in the segment following that which contains the testes, so that the vasa deferentia like the nephridia traverse two segments, the internal funnel being situated in one and the external orifice in the next.

In the example of *Moniligaster Barwelli* described above the vas deferens is confined apparently to one segment; but in other specimens the testes themselves lie in two segments (8 and 9), projecting through the mesentery, so that the internal funnel of the vas deferens, which is represented by the outer tunic of the testis, in reality does traverse two segments. Furthermore there is an agreement with many of the Limicolæ in the forward position of the testes and male generative opening. In earthworms there are invariably two pairs of vasa deferentia, which may (*Urochæta*) or may not (*Acanthodrilus*) become fused posteriorly into a single tube on either side, and they traverse several segments (sometimes as many as six) on their way to the exterior. There is evidently a great difference from the disposition of the male organs of *Moniligaster Deshayesi*. In *Moniligaster Deshayesi* the male generative organs have a disposition which is, so far as is

known at present, unique among the Oligochæta. There are two pairs of testes in the 8th and 10th segments respectively; each of these opens on to the exterior by a separate vas deferens furnished at its termination with a prostate gland; the anterior pair of apertures are placed in the 7th segment in front of the testes belonging to them, the latter between the 10th and 11th segments behind their testes. This latter pair of apertures correspond exactly to those which I have found in *M. Barwelli*. The anterior pair of testes together with the accessory structures were entirely absent; but in this segment were a pair of copulatory pouches (fig. 5) opening on to the exterior in front of the outermost pair of setæ. The copulatory pouches are remarkable from the fact that the pouch itself is a small spherical vesicle communicating with the exterior by a long, slender, variously coiled and contorted duct, which, together with the pouch, is closely applied to the mesentery dividing the segment from the one in front. The length of the duct is remarkable and recalls the copulatory pouch of certain Limicolous Oligochæta (e. g. *Anachaeta Eiseni*, Vejdovsky, *loc. cit.* pl. vii. fig. 22). The presence of a pair of copulatory pouches, instead of an anterior pair of testes and vasa deferentia, brings the structure of the genital apparatus in this species much nearer to the usual condition met with in earthworms. M. Perrier's account of the male genital apparatus of *M. Deshayesi*, which is illustrated, is too circumstantial to admit of any doubts of its accuracy, though there is evidently some resemblance between the vas deferens ("entortillé comme serait un Gordius") of *M. Deshayesi* and the convoluted duct of the copulatory pouch in the present species.

I feel uncertain therefore whether there is a real difference between the two species in the structure of the male genital organs, or whether the anterior testes and their ducts may not, as M. Perrier suggests, be developed at different times; at the same time it seems hardly likely that the vasa deferentia and prostates would disappear with the testes, and I am certain that a second pair of these structures did not exist in the specimens of *M. Barwelli* which I have examined. Moreover, a comparison of M. Perrier's figures of the posterior testes with their ducts and accessory structures* with my own (fig. 4) will show that there is sufficient difference to separate the two forms, at least specifically, without reference to the presence or absence in *M. Barwelli* of the anterior testes.

* *Loc. cit.* pl. iv. figs. 79 and 81.

EXPLANATION OF PLATE II.

- Fig. 1. *Perichæta ceylonica*. Clitellum and neighbouring segments: *a* and *b*, openings of glands lettered *a* and *b* in fig. 2.
- Fig. 2. Prostate glands of same: *a*, coiled tubular gland; *b*, multilobate gland.
- Fig. 3. Genital seta of same.
- Fig. 3 *a*. Distal extremity of genital seta.
- Fig. 4. Diagrammatic transverse section of segment 9 of *Moniligaster Barwelli*. *a*, alimentary canal; D, dorsal blood-vessel; *y*, ventral blood-vessel; *n*, nerve-cord; T, testis; *v.d.*, vas deferens; *p*, prostate; *v.s.*, lateral blood-vessel connecting dorsal and ventral blood-vessels; *s*, ventral pair of setæ; *s'*, dorsal pair of setæ.
- Fig. 5. *C.p.*, copulatory pouch of same; *n*, nerve-cord; *s*, ventral pair of setæ; *s'*, dorsal pair of setæ.
- Fig. 6. Portion of vas deferens of same (*v.d.* in fig. 4), highly magnified.
- Fig. 7. Copulatory pouch of an example of *Perichæta posthuma*; three pouches in one segment (no. 8).

XI.—Some new Infusoria from American Fresh Waters.—
No. 2. By Dr. ALFRED C. STOKES.

[Plate I.]

Heteromita variabilis, sp. nov. (Pl. I. fig. 1.)

Body soft, flexible, and very changeable in shape, subspherical, ovate, elongate, subcylindrical, frequently with both extremities curved towards the ventral aspect, and often with the anterior border slightly and obliquely emarginate; endoplasm granular; flagella very unequal in length, the trailing appendage twice as long as the contracted body, the vibratile one third or one fourth of the length of the body; contractile vesicle single, spherical, located near the centre of the ventral surface; nucleus single, subspherical, near the posterior extremity. Length of body $\frac{1}{2250}$ to $\frac{1}{1125}$ inch.

Hab. The apparently empty body of a dead *Canthocamptus minutus*, Müller.

Fig. 1 shows some of the changes in form assumed by this remarkably metabolic creature, of which the posterior extremity is especially soft and changeable in shape. The infusorian differs from all other members of its genus in the proportionate length of the flagella, the vibratile appendage being shorter than that of any previously recorded species. The animalcules were observed crowding the empty body of a dead *Canthocamptus*.

Paramonas alata, sp. nov. (Pl. I. fig. 2. Diagram.)

Body ovate, persistent in form, about twice as long as broad, widest and rounded posteriorly; traversed longitudinally